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A REVIEW OF REVERSE OSMOSIS AND ITS MEMBRANE, INDUSTRIAL APPLICATION

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ABSTRACT

The water is at higher risk as its remediation is very difficult. The major an thropogenic activities for continuous water quality deterioration are urbanization , industrialization and agricultural runoff . Appropriate 70 % of India and 25% of the other world has not assesible and safe drinking purpose water . The use of artificial chemicals contain to contaminate many of the precious water sources worldwide. Also, soil contains the fluoride arsenic as well as redioacting element are polluting the sources of water . Thus, to remove the above impurities from the sources , we have to goes for special type of processing . The household filters and methods only separate out the particulate matter . The traditional methods like ultra- filtration do not remove the most of the heavy toxic chemicals from water which can harm humans. The toxic chemicals as well as other impurities are achieved by the universal method called as reverse osmosis hence the present short review shows the applicability of RO system for treating the effluents from water.

KEYWORDS: Water pollution, reverse osmosis, osmotic pressure, membranes, pfeffer method.

1. INTRODUCTION

The principle behind the theoretical concept of reverse osmosis is the reversal solvent flow from higher concentration to lower concentration solution through a semipermeable membrane by applying an external pressure slightly higher than osmotic pressure of higher concentration solutions . The process that uses semipermeable membrane spiral wound to remove organic, pyrogens, colour, nitrate, submiron colloidal matter and bacteria from water.

Water is universal chemical liquids used for drinking which is most essential the water contain totally on the earth is 71% as well as the variations are as icecaps holds 2% approximately drinking water, lakes contain 1% of drinking water also out of this 71% the 97% is not good for drinking and industrial use d approximately two-billion people in the world do not have access to safe drinking water [1].In the reverse osmosis the water which goes from semipermeable membrane is known as permeate water the impurities like organic solids are removed by semipermeable membrane in RO system

2. NEED OF CLEAN WATER

There is co-relation between the clean water and human health, health is depend upon quality of water. Almost all countries have environment protection laws those including water resources. But, actual use of these laws are mostly variable and adherence often is poor[2]. Every year, many million people die because of contaminated water. In many cases, the death is due underestimated[4]. These thing because more frequent and major, but often forgotten sources of water contamination.

3. IMPORTANCE OF REVERSE OSMOSIS

The process of reverse osmosis becomes more effective of treatment for the industrial and municipal pollute water. Since municipal community do not remove the impurities from household runoff [5]. Also, some industries does not take seriousness about wastewater. Hence the RO process is used in both municipal waste and industrial waste filtration. It is seen from literature review osmosis has been widely used for separation and concentration of solutes in many fields[6]The extraction of organic components by reverse osmosis process discovered by Chain Et al (1975). The presence of individual contaminants can causes problem, hence the removal of individual contaminants by RO has been studied by researcher Murthy et al.(1999). Reverse osmosis process removes fluorides proportionally ,if total dissolve salts are at tolerable level and fluoride contain is high then one can use special alum resin filter, work under gravitational force.(Krishnan S. et al.)(2005).

3.1. Understanding of osmotic pressure:

The osmotic pressure is calculated with the help of colligative properties of solutions as Well as solvents like lowering in vapour pressure, elevation in boiling point, and depression in freezing point [8]. In advancing, the several commercial devices can be measures osmotic pressure directly like as pfeffer's metod.

3.2. Pfeffer's method:

A porous pot fitted with a membrane made of copper ferrocynide. The cell is fitted with a 3% solution of $K_4[fe(CN)_6]$ and the cell is placed in 3% $CuSO_4$ solution. Ions formed lead to precipitate of copper ferrocynide in the pores of the pot. The cell is washed thoroughly with water and then filled with the solution whose osmotic pressure to be measured. The mercury manometer is attached to the bottom of pot, a glass tube which measures the osmotic pressure of the solution at constant temperature. The osmotic pressure varying with temperature and concentration of solution.

3.3. Treatment option for reverse osmosis:

In order to purity wastewater, Indian distillery uses various forms of primary, secondary and tertiary treatment of wastewater. Biomethanation use the unit process like screening as well as equalization. Process stream that can be recycle are namely, thin slop and process condensate [9]. The effluent generated offer removal of solids. Thin slop contains carbohydrate, organic acids dead yeast cells etc. which may have impact on fermentation process. This process condensate from the evaporator has high temperature, low ph, organic acid etc. this can be treated by RO system and used in the process or for utility operation.

4. REVERSE OSMOSIS PROCESS

The flow of pure water from the fresh to the saline side will continue until a chemical potential between the two sides is obtained. At this point the flow of pure water is stop. This is called "osmotic equilibrium", if follows that if the pressure on saline side were now to be increased, the flow could be reverse [10]. That is flow water is directed from saline side to the fresh water is called 'reverse osmosis". It occurs by increase in pressure on saline side. The reverse osmosis is a simple in design consisting feed, permeate as well as rejection steam.

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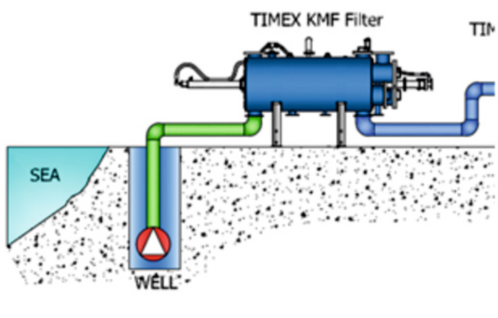

5. REVERSE OSMOSIS REQUIREMENT

The RO desalination plant set up four step units

a) Pretreatment unit
b) High pressure pump
c) Membrane system
d) Past-treatment

The first unit pre-treatment is provided to removal large size suspended solids so that salt precipitation and microbial growth doesn't occur on the membrane. This involves methods like sedimentation, flocculation, sand filtration, boiling which remove the dissolve gaseous, for the increasing pressure above osmotic pressure the high pressure pump is used. The membrane consists of semi permeable membrane and pressure vessels. Semi permeable membrane and pressure vessel semi permeable membrane permit the water to pass through it. Depending upon the permit the use of post treatment like the pH and disinfection [12].

6. RO MEMBRANE PREPARATION AND PROPERTIES

Reverse osmosis membrane separation are governed by the properties of the membrane used in process. These properties depend material as well as physical structure most currently available RO membrane fall into two categories.

6.1Symmetrical membrane:

It contain one polymer and thin film composite membrane consisting of two or more polymer layers. SymmetricalRO membrane has a very thin, perm selective skin layer supported on a more porous sub layer of the same polymer. The membrane to water transport (which is proportional to the dense skin thickness) is much lower and on a result water fluxes much higher than those through comparable symmetrical membrane.

6.2 Preparation:

Symmetrical membranes are most commonly formed by a phase inversion (polymer precipitation) process in this, a polymer poor liquid phase that forms the membrane pores of void space. The polymer precipitation can be achieved in several ways including thermal gelatin solvents evaporation or non-solvent immersion is the most important symmetrical preparation tech. widely used of symmetrical membranes includes cellulose acetate membranes and linear aromatic polyamide membrane.

6.3 Composite membrane/ asymmetrical membrane:

Composite membrane consist of polymer barrier layer formed on one or more porous support layers. The surface layer determines flux and separation characteristics of the membrane transport properties the barrier layer is extremely thin, on the order to 0.1 um or less, thus allowing water fluxes [17].

6.4 Preparation:

The most important thin film, composite membrane are made by interfacial polymerization a process in which a highly porous membrane (usually polysultone) is coated with a polymer or monomer and then reacted with a cross-linking agent. A dense, cross-linked polymer layer forms at a solution interface and since the cross linking reaction occurs mostly at the solution interface the resulting barrier layer is extremely thin. Most widely used thin film composite membranes consist of cross linked aromatic polyamide on a polysulfide support layer.

7. MEMBRANE FOULING

Fouling of RO membrane is defined operationally here in as the reduction in water transport per unit area of membrane (fluxes) caused by a substances in the feed water that accumulate either on or in the membrane while there are several common causes of RO membrane fouling.

Colloidal fouling-The mechanism of action for colloidal fouling of RO membranes is not entirely clear. Conflicting reports as to the ideal operating conditions required to reduce colloidal fouling suggest that several physic-chemical factors may be involved two mechanisms, colloidal stability and concentration polarization [18].

8.COLLOIDAL STABILITY

Colloidal stability refers to the tendency of colloidal particles to settle of solution stable colloids do not settle out readily unstable colloidal tend to agglomerate and settle out. It is generally accepted that the stability of colloidal particle is due to their small size and surface charges of the particles. The small size and density of the individual particles alone would permit them to stay in suspend in definitely.

Colloidal concentration-As the feed water is passing through the membrane colloids suspended in the feed water are rejected by the membrane and concentrated.

9.BIOFOULING

As the biofilm matures more bacterial growth and extracellular polymers are added to the biofilm. Biofilm growth eventually become limited by the shared force of the bulk feed stream. It appears that the outermost layer of biofilm is last compact. It may be that with time the older biofilm layer compress forming a more impermeable barrier.

10. CLEANING

We can't prevent fouling layers, but we can remove them once. Remove at and established fouling layers is attempted by exposing it to disinfectants and chemical cleaning agents .The effectiveness of removal varies from minimal to nearly 100%,depending upon to the nature of fouling layer on the cleaning/sanitizing formulation used and on the cleaning procedure.

11. SELECTED WASTEWATER APPLICATION OF REVERSE OSMOSIS

Application	Species removed	Reference
Food Processing Effluent Treatment	Meat Processing COD, Olive Mills COD,TDS, Various contaminants	Hart and Square(1985); Anonymous(1988); Mohr et al.(1989).
Groves	Compounds	Jonsson and Wimmerstedt(1985); Ekengren et al.(1991).
Electroplating and Metal-finishing Rinse Water Treatment	Nickel, chromium, gold; Aluminum, phosphoric acid; Various metals ; Cadmium.	Imasu(1985); Thorsen(1985); Davis et al.(1987); Slater et al.(1987).
Pulp and Paper Processing Effluent Treatment	Spent sulphite liquor components; Wash water components; Bleach plant.	Glimenius(1980); Hart and Square(1985); Dorica et al.(1989).
Organic Pollutants Removal	Various Organics; Herbicides ,Pesticides; Polar Organics; Phenolic.	Shuckrow et al.(1981); Edwards and Schubert(1974); Fang and chian(1976); Koyama et al.(1984).

12. ADVANTAGES OF RO PROCESS

Following advantages shows the RO is make dilute aqueous water for drinking and industrial purpose;

1. RO removes all ionic, non-ionic, organic impurities from water.
2. Easy to establish, simple to operate and has low cost process.
3. Pure water for high pressure boiler, reaction and drinking purpose obtained
4. The efficiency of the process depends upon stability of semipermeable of membrane under chemical, physical and thermal change.
5. It only removed specified quantities salt and some salt and minerals are passed through it for drinking useful.
6. The process is electrically driven hence at also adoptable to powering by a solar panels.
7. RO system allows recovery/recycle of waste process with no influent on the material being recovered.
8. It requires less energy as compress to other technologies.
9. The RO plant normally operates at ambient temperature which reduces the scale formation and corrosion problem, because of antiscalent and biodiapersent use, which all reduces maintenance cost.

11. CONCLUSION

The RO technology present an effective means of removing pathogens for many facilities, this method may not be cost effective for treating the entire irrigation and other water polluted system[13]. No intervention has greater overall impact on national development, public, health and the longevity of human than the provision of safe drinking water and the proper disposal of human waste[4]. A high incidence of chronic kidney diseases of multifactorial origin(CKD-mfo)[14]is reported in sri-lanka[15,16].

The RO system depend upon efficiency of pretreatment as well as post treatment.Post treatment of brine streams present a major problem growing desalination capacity to minimize the damage on the ecology which depend upon the location of plant.

REFERENCES

1. Wahlqvist, M.L. and K.N. Kuo, Securing health through food systems: an initiative of the nutrition consortium of the National Health Research Institutes in Taiwan and Asia Pacific regional partners as a network. Asia Pac J Clin Nutr, 2009. 18(4): p. 472-9.
2. Krishnan S., Kampman, D., Kumar S. and S.Nagar, Groundwater and well water quality inalluvial aquifer of central Gujarat, in Proceedings of IWMI-Tata Water Policy Programme Annual Partner's Meet, Anand, Gujarat,2005
3. Hunter, P.R., J.M. Colford, M.W. LeChevallier, S. Binder, P.S. Berger Panel on Waterborne Diseases: Emerging Infectious Diseases Conference in Atlanta, Georgia. Emerging Infectious Diseases Journal, 2000. 7(3): p. 544-545.
4. Arsuaga, J.M., M.J. Lopez Munoz, A. Sotto and G. del Rosario, (2006)," Retention of phenols and carboxylic acids bynanofiltration/membranes: Sieving and membrane solute interaction effects ",Desalination, 731- 733.
5. Glater, J., The early history of reverse osmosis membrane development. Desalination 1998. 117: p. 297–309.

6. Bhattacharyya, D., and Madadi, M.R., (1988):"Separation of Phenolic Compounds by LowPressure Composite Membranes: Model Mathematical and Experimental Results", AIChESymposium Series, 84, No. 261, 139.

7. Chian, E., Bruce, W., and Fang, H., (1975): "Removal of Pesticides by Reverse Osmosis", Environmental Science and Technology, 9, 364.

8. Krishnan S., Kampman, D., Kumar S. and S. Nagar, Groundwater and well water quality in alluvial aquifer of central Gujarat, in Proceedings of IWMI-Tata Water Policy Programme Annual Partner's Meet, Anand, Gujarat,2005

9. G. Srinivasan,,S. Sundaramoorthy and D.V.R.Murthy (2010):," Spiral Wound Reverse OsmosisMembranes for the Recovery of PhenolCompounds-Experimental and ParameterEstimation Studies," American J. of Engineeringand Applied Sciences 3 (1): 31-36

10. Kurihara, M., Harumiya, N., Kanamaru, N.,Tonomura, T., and Nakasatomi, M.(1981):",Development of the PEC-1000Universal Journal of Environmental Research and Technology238.

11. Pusch, W., Yu, Y., and Zheng, L., (1989): "Solute-Solute and Solute-Membrane Interactions inHyperfiltration of Binary and Ternary AqueousOrganic Feed Solutions", Desalination, 75, 3.

12. Zhang S., Yang F., Liu Y., Zhang X., Yamada Y. andFurukawa K., (2006):. Performance of a metallicmembrane bioreactor treating simulateddistillery wastewater at temperatures of 30 to45 ºC, Desalination, 194, 146-155.

13. Hazardous Industrial Wastewaters", Current Practices Environmental Science, 3, 1 (1987b).Slejko, F., Adsorption Technology, Marcel Dekkar, Inc., New York (1985).Soltanieh, M., and Gill, W., "Review of Reverse Osmosis Membranes and Transport Models",Chemical Engineering Communications, 12, 279 (1981).

14. Bodalo-Santoyo, A., J.L. Gomez-Carrasco, E.Gomez-Gomez, F.Maximo-Martin and A.M.Hidalgo-Montesinos,(2003):,"Application ofreverse osmosis membrane to reduce pollutantspresent in industrial waste water , "Desalination,155: 101-108.

15. Senevirathna, L., et al., Risk factors associated with disease progression and mortality in chronic kidney disease of uncertain etiology: a cohort study in Medawachchiya, Sri Lanka. Environ Health Prev Med, 2012. 17(3): p. 191-8.

16. Nanayakkara, S., et al., Evidence of tubular damage in the very early stage of chronic kidney disease of uncertain etiology in the North Central Province of Sri Lanka: a cross-sectional study. Environ Health Prev Med, 2012. 17(2): p. 109-17.

17. J.W. Lee, T.O.Kwon, I.S. Moon, Performance of polyamide reverse osmosismembranes for steel wastewater reuse, Desalination 189 (2006) 309–322.

18. A. Sagiv, R. Semiat, Backwash of RO spiralwound membranes, Desalination 179(2005) 1–9.